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(54) Title of the Invention: LIQUID CRYSTAL DISPLAY DEVICE

SPECIFICATION

1. Title of the Invention

LIQUID CRYSTAL DISPLAY DEVICE

2. Scope of Claims

[Claim 1] A liquid crystal display device comprising:

a display electrode and a bus line for supplying voltage to the display electrode, each of which is formed over a principle surface of a first substrate; and

an electrode opposing to the display electrode over a principle surface of a second substrate;

wherein the principle surfaces of the first substrate and the second substrate are opposed to each other, periphery portions of the principle surfaces are bonded to each other so that the substrates have a space therebetween to hold a liquid crystal, and a dummy wiring which has nothing to do with electric connection which penetrates into an adhesive portion is formed in at least the adhesive portion over the first substrate.

[Claim 2] The liquid crystal display device according to Claim 1, wherein the dummy wiring is formed in the corner of the first and second substrates.

3. Detailed Description of the Invention

[Industrial Field of Application]

The present invention relates to a display device, particularly, to a liquid crystal display device.

[Prior Art]

A liquid crystal display device is generally manufactured in accordance with the following procedure, that is, one electrode group is formed over the principle surface of a first substrate, the other electrode group is formed over the principle surface of a second substrate, and both of the principle surfaces of both of the substrates are bonded to each other at the periphery portion so as to oppose to each other, then, a liquid crystal is held in a space formed by both of the substrates and an adhesive portion. In order to keep the space (gap) having a predetermined design value, glass fiber or a spherical substance, each of which has a specific diameter, is used as a spacer to be dispersed between the substrates.

[Problems to be Solved by the Invention]

In recent years, the control of the thickness of a liquid crystal layer has become an extremely important subject in addition to the improvement of the performance of a liquid crystal display device. That is, a multi-gap full color liquid crystal display device has been put to a practical use in order to improve visual quality in the case of using the conventional twisted nematic (TN) liquid crystal. In that case, the thickness of the liquid crystal layer serves as an important parameter for the visual quality. In a super twisted structure, the control of an optical path length in a liquid crystal is also important. The thickness of a liquid crystal layer (hereinafter, gap) should be uniformly controlled over the whole area of a display portion in a display device. In the case that uneven gaps are if only partially presented, the uneven gaps cause unevenness of display, which leads to the deterioration of visual quality. Therefore, holding a gap uniformly over a whole area of the display portion is an extremely important industrial subject.

In the case that both of the principle surfaces of two substrates are completely plane, dispersed spacer substances having specific diameters are subjected to equal forces from both of the substrates. The gap is determined by the diameters of the foregoing substances. However, the principle surface of the substrate for the liquid crystal display device is not plane in a precise sense, since a display electrode or other structures are formed over the principle surface. Especially, the surface of the substrate provided with active elements such as a thin film transistor (TFT) and a diode normally has display depressions and projections with a thickness of approximately several thousands Å to 1 μm. In that case, the gap is not determined only by the specific diameter of the foregoing substances, but also both of the heights of projections over the substrate surface and the specific diameter.

The depressions and projections over the substrate surface are not always uniformly distributed over a whole area of the substrate surface. In particular, a region for bonding both of the principle surfaces of both of the substrates to each other usually includes a region provided with wirings for feeding a display element. The wirings are not always uniformly distributed, that is, some of the wirings are densely

arranged in a certain region, whereas any wiring is not provided in another certain region. In that case, a large gap is observed at the periphery of the region where wirings are densely arranged, whereas a small gap is observed at the periphery of the region where any of the wirings is not provided.

Therefore, unevenness of the gap is often observed especially at the periphery of the display device.

[Means for Solving the Problems]

It is an object of the present invention to prevent the occurrence of unevenness of a gap by forming uneven shapes by, for example, dummy wirings made from the material used for forming a feeder line especially in a region that does not normally require the feeder line crossing an adhesive portion from the consideration of the design of feeding function, so that projections and depressions are almost uniformly formed at least in a region where a gap is formed, in the case of using a substrate in which depressions and projections are formed over a principle surface, in order to solve the foregoing problems.

[Operation]

The depressions and projections are formed uniformly over a principle surface, which makes it possible to achieve the uniformity in a gap that is determined by the height of the projection and the diameter of a spacer over a whole area of a display substrate.

[Embodiment]

FIG. 1 is a partial enlarged view of a liquid crystal display device according to one embodiment of the present invention. In this embodiment, the liquid crystal display device has an image display portion 2 provided with 240 lines \times 372 columns of, for example, amorphous silicon (a-Si) thin film transistors (TFTs) serving as switching elements and display electrodes over the principle surface of a first transparent glass substrate, in which each of the TFTs (not shown) is provided at the intersection of 240 gate bus lines 2A with 372 source bus lines 2B. Each of the gate

bus lines 2A is connected via a connection wiring portion 4 for the gate bus lines to a connection terminal portion 3 for a gate driver circuit that is wired at the outside of the substrate. Similarly, the signal bus lines (source bus lines) 2B are connected via a connection wiring portion 6 for the signal bus lines to a connection terminal portion 5 for a signal voltage supply circuit provided at the outside of the substrate.

On the other hand, the substrate 1 is required to be bonded to a second substrate (not shown in FIG. 1) that is provided to be opposed to the first substrate with a bonding portion 7 (which is indicated by a dashed line in FIG. 1). The predetermined numbers of dummy wirings 8 that are unable to function electrically at all are provided in order to uniformly distribute depressions and projections over the surface at the adhesive portion and the inside thereof in the region which has no connection wirings.

That is, the dummy wirings 8 may be formed simultaneously with the bus lines and the connection wirings. The dummy wirings 8 are formed in a corner portion of the first substrate 1. The corner portion is a part of a display substrate and not provided with the connection wirings 4 and the connection wirings 6. Further, the dummy wirings 8 can be provided between the wirings 4 in the portion where the spaces between the wirings 4 are wide, that is, the wirings 4 are thinly distributed. Much the same is true on the wirings 6.

FIG. 2(a) is a view for showing a connection wiring portion in the liquid crystal display device according to the present invention. FIG. 2(b) is a view for showing except the connection wiring portion, that is, the upper right corner portion in FIG. 1. Reference numeral 10 denotes the second transparent substrate; 11, a liquid crystal; and 12, an adhesive around the liquid crystal. The TFTs, a color filter, and the like are not illustrated. Therefore, a gap l_1 and a gap l_2 can be approximately equalled to each other according to the invention.

In a liquid crystal display device formed by combining the first substrate 1 provided with the dummy wirings 8 and the second substrate 2 (a color filter substrate in the case of color display), a uniform gap (variations $\pm 0.1 \mu\text{m}$) can also be held in the upper right corner portion in the display portion 2 shown in FIG. 1 in the case that the gap has a thickness of 5 to 6 μm .

However, in a liquid crystal display device formed by combining the first substrate that is not provided with the dummy wirings portion and the second substrate, a gap in the foregoing upper right corner portion becomes clearly decreased by approximately $0.8\ \mu\text{m}$, which leads to the deterioration of visual quality. The degree of the decrease is comparable to the thicknesses of the depressions and projections of the connection wiring portions 4 and 6. That is, Al wirings with thicknesses of $0.8\ \mu\text{m}$ are used for the connection wirings 4 and 6, and the gap is partly decreased by $0.8\ \mu\text{m}$, which leads to the serious deterioration of visual quality.

[Effects of the Invention]

As explained with the foregoing embodiment, the uniform thickness of a liquid crystal layer can be held over a whole area of a display portion of a liquid crystal display device according to the present invention. Especially in a twisted nematic or super twisted liquid crystal display device, especially in a ferroelectric liquid crystal display device that are susceptible to an optical path in a liquid crystal, unevenness of a gap has a serious adverse effect on visual quality. For example, the super twisted ferroelectric liquid crystal display device requires gap accuracy in a predetermined value range of $\pm 0.2\ \mu\text{m}$ or less. A display device having a further gap difference cannot help being regarded as an inferior good. In a multi-gap full color liquid crystal display device using twisted nematic, the tolerance of a gap error becomes slightly increased, and so it is obvious that the gap error is desirably controlled to the vicinity of a predetermined value. A display device having a local gap decreased region by $0.8\ \mu\text{m}$ generated in the case of removing a dummy wiring inevitably becomes an inferior good.

As noted above, the cause of a gap failure can be removed by an extreme simple structure, and a liquid crystal display device having extreme good visual quality can be manufactured in a stable yield according to the invention.

In this embodiment, a dummy wiring (a) is formed in a linear shape. Alternatively, the dummy wiring can be formed in a dotted shape or another shape still having the same function.

4. Brief Description of the Drawings

FIG. 1 is a partial enlarged plan view of a principle surface of one substrate of a liquid crystal display device according to one embodiment of the present invention; and

FIG. 2 is a partial cross-sectional view of the liquid crystal display device.

1, 10: substrates; 2: image display portion; 3,5: connection terminal portions; 4,6: connection wiring portion; 7: adhesive portion; and 8: dummy wiring.

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